ICT Role for Smart Sustainable Cities

Smart Sustainable Cities

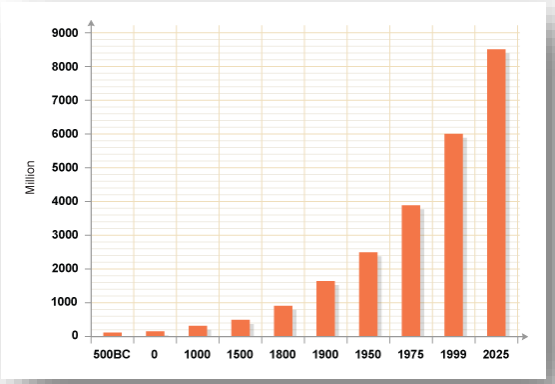
Training Programme Module 1

SSC-1

Contents

- Introduction
  - Arriving at a definition
  - Motivation and goal
  - How can cities be made sustainable?
  - Focus Group on SSCs
- City ‘Dimensions’ and Attributes
  - Environment and sustainability
  - Services
- Data Management
- Smart Services
- Infrastructure
- Exercises

Motivation for Smart Sustainable Cities



- Population Growth has been 1.2% pa over the last 50 years
- In 2007 the number of people living in cities surpassed the number of people living in rural areas
  - Socio-economic development in urban areas is a factor leading to migration to cities
- Studies have demonstrated that cities are accountable for approximately 70% of global greenhouse gas emissions* as well as 60-80% of global energy consumption**

Sources : FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)"
*http://mirror.unhabitat.org/downloads/docs/E_Hot_Cities.pdf
**http://www.un.org/en/sustainablefuture/cities.shtml

ITU-T Focus Group on Smart Sustainable Cities

- A group parented on ITU-T Study Group 5
  - "Environment and climate change"
- Open to all
- Is part of the United Nations organisational structure
- First meeting was in May 2013, Turin, Italy
- 7th Meeting March 2015, Reading, United Kingdom

http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx

ITU-T FG-SSC Objectives

- Define the role of ICTs in cities that aim to be environmentally sustainable
- Establish liaisons and relationships with other organizations
- Establish a roadmap of the ICT sector contribution to smart and sustainable cities (and route to standardisation)
- Suggest future ITU-T study items for ITU-T SG5 on:
  - Concepts, coverage, vision and use cases of smart and sustainable cities
  - Characteristics and requirements of smart and sustainable cities
  - Efficient services and network infrastructure of smart and sustainable cities
- Identify or develop a set of key performance indicators (KPIs)
- Foster best practices to help cities deliver ICT environmental services and build resilience to climate change in cities.
- Identify potential barriers in the use of ICTs in cities
- Set up a global gateway on ICTs contribution to smart and sustainable cities.

Source: http://www.itu.int/en/ITU-T/focusgroups/ssc/Documents/ToR_FG%20SSC.docx
Summarised from the "Terms of Reference"

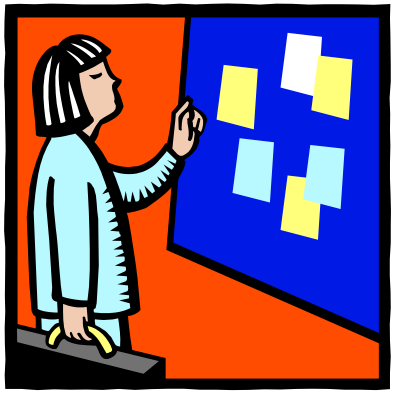
Definition

"A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects".

Source: FG SSC Doc 100 "Smart Sustainable Cities: An Analysis of Definitions"

How did the ITU-T Focus Group on Smart Sustainable Cities (ITU-T FG SSC) arrive at this Definition#1?

- Approximately 120 existing definitions of Smart Sustainable Cities were studied and analyzed
- From
  - Academia & Research Communities
  - Government Initiatives
  - International organizations (United Nations, ITU, etc.)
  - Corporate / Company Profiles, etc.
- Eight key 'Categories' were established
  - Quality of Life and Lifestyle
  - Infrastructure and Services
  - ICT, Communications, Intelligence and Information
  - People, Citizen and Society
  - Environment & Sustainability
  - Governance, Management and Administration
  - Economy and Finance
  - Mobility



Sources: FG-SSC 'An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)' and FG-SSC 'Smart Sustainable Cities: An Analysis of Definitions'

How did ITU-T FG SSC arrive at this Definition#3?

- Within these 8 categories, the most frequently used keywords were prioritised so that a definition could be constructed with which the whole Focus Group agreed

"A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects".

Sources: FG SSC 'Smart Sustainable Cities: An Analysis of Definitions', page 9

Keyword	Total Occurences	% Occurrence
Quality of Life	44	6%
Development	16	2%
Services	10	1%
Buildings	17	2%
Health, Safety and Security	26	4%
Utilities	3	0%
Education	16	2%
Energy	17	2%
Water	16	2%
Electricity	3	0%
Modern	2	0%
ICT	27	4%
Technology	42	6%
Interconnected	1	0%
Information	24	3%
Communication	15	2%
Intelligent	16	2%
Integrate	22	3%
Systems	34	5%
Advanced	1	0%
Design	4	1%
Community	5	1%
Accessible	2	0%
People	36	5%
Urban	16	2%
Society	6	1%
Actively	4	1%
Innovation	15	2%
Aware	2	0%
Participatory	3	0%
Efficient	24	3%
Sustainable	28	4%
Adaptable	3	0%
Optimal	2	0%
Environment	22	3%
Resources	27	4%
Natural	11	2%
Governance and Administration	35	5%
Management	20	3%
Capital	4	1%
Operational	1	0%
Public	6	1%
Solutions	4	1%
Vision	1	0%
Economy	34	5%
Investments	9	1%
Business	13	2%
Competitive	5	1%
Mobility	14	2%
Transport	18	2%
Total	726	100%

Specification for a Smart Sustainable City

- A Smart Sustainable City is a city that leverages the ICT infrastructure in an *adaptable, reliable, scalable, accessible, secure, safe and resilient* manner in order to:
  - Improve the Quality of Life of its Citizens
  - Ensure tangible economic growth such as higher standards of living and employment opportunities for its citizens.
  - Improve the well-being of its citizens including medical care, welfare, physical safety and education.
  - Establish an environmentally responsible and sustainable approach which "meets the needs of today without sacrificing the needs of future generations".
  - Streamline physical infrastructure based services such as transportation (mobility), water, utilities (energy), telecommunications and manufacturing sectors.
  - Reinforce prevention and handling functionality for natural and man-made disasters including the ability to address the impacts of climate change.
  - Provide an effective and well balanced regulatory, compliance and governance mechanisms with appropriate and equitable policies and processes in a standardized manner.

Source: ITU-T FG SSC 'Smart sustainable cities: An analysis of definitions ' Page 12

What happens when a City is not Smart and Sustainable?

Infrastructure grows but is not well-connected, resulting in

- traffic jams
- missed buses, trains and flights
- adverse impact on climate and city skyline
- Interoperability challenges
- Lack of coordinated response to disaster
- sources of information are not available
- shortages of supply occur
  - Electricity, water and food
- duplication of resources

Source: David Faulkner

What is the Main Goal of a SSC?

To enhance the quality of life of its citizens across multiple, interrelated dimensions, including

- the provision and access to
  - water resources
  - energy
  - transportation and mobility
  - education
  - environment
  - waste management
  - housing
  - livelihoods (e.g. jobs)

….utilising ICTs as the enabler

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)"

Challenges facing SSCs

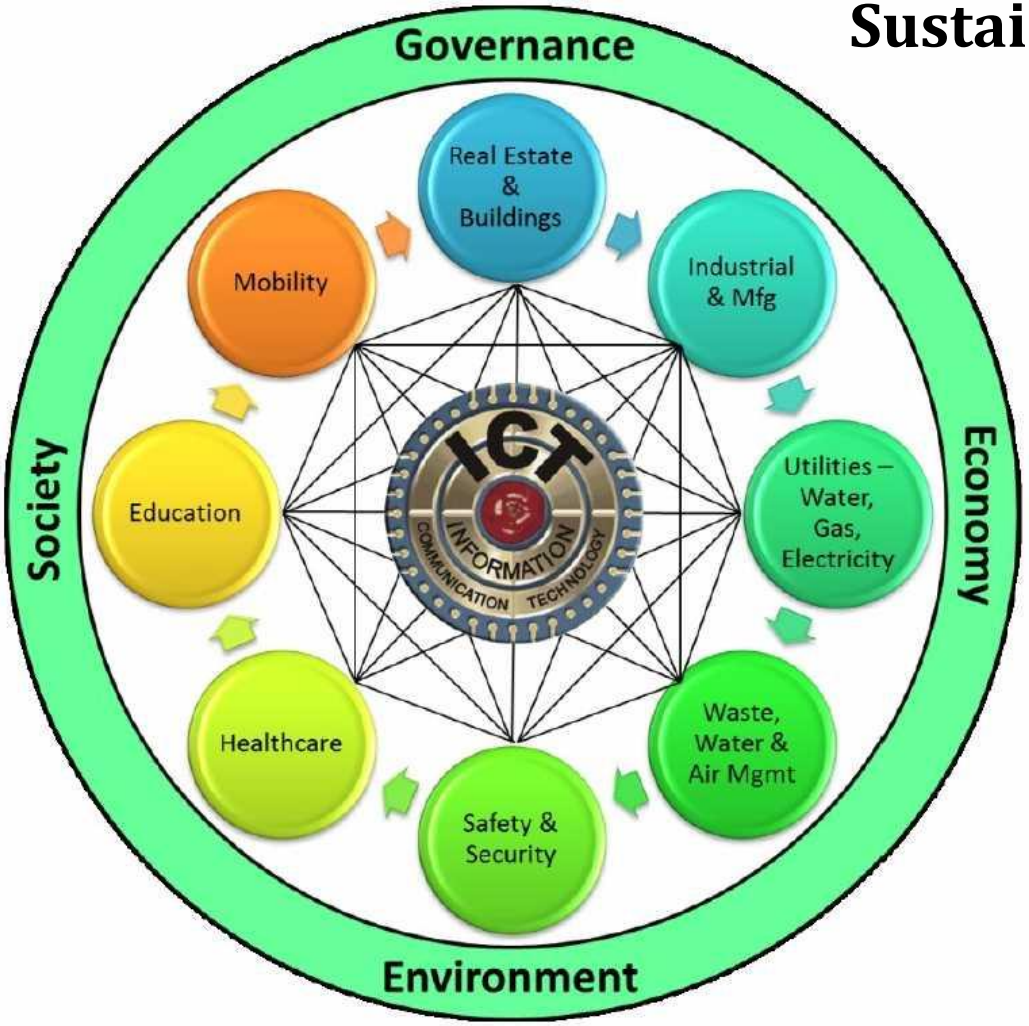
- Urban migration
- Environmental degradation
- Climate change impacts
- Aging infrastructure
- Limited resources

ICTs can act as a platform to help overcome these challenges and take advantage of emerging opportunities

Source: FG-SSC “An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)”

Next:
City Dimensions and Attributes

Pictorial Representation of a Smart and Sustainable Urban Landscape



Note that a single interoperable ICT infrastructure is essential.

After the Fukushima Tsunami, "lack of interoperability between the first respondents and other corresponding civic agencies significantly hampered rescue efforts"

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" pages 10 and 26

Core Pillars of a Smart Sustainable City

Economy	Governance	Environment	Society
•Employment •GDP •Market – Global / Local •Viability •Investment •PPP •Value Chain •Risk •Productivity •Innovation •Compensation	•Regulatory •Compliance •Processes •Structure •Authority •Transparency •Communication •Dialog •Policies •Standards •Citizen Services	•Sustainable •Renewable •Land Use •Bio-Diversity •Water / Air •Waste •Workplace	•People •Culture •Social Networks •Tech Savvy •Demographics •Quality of Life •User Experiences •Equal Access •End Consumers •Community Needs •The City as a Database

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)", page 9

City 'Dimensions'

- Broadly speaking, there are three overarching and closely interrelated 'dimensions' at the core of a city:
  - Environment and Sustainability
  - City Level Services
  - Quality of Life

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)"

'Environment and Sustainability' Details

City Infrastructure and Governance			
Policy and Management		**Infrastructure**	
• Integrated Environmental Management • Strategy • Municipal Administration • Effective Conservation		• Urban Planning • Buildings and Physical Infrastructure • Mobility, Transportation and Traffic • Public Safety	
Energy and Climate Change			
CO_2 Emissions		**Energy**	
• CO_2 from Energy Production • Emissions per Capita		• Energy Performance • Conservation	
Pollution and Waste			
Waste	**Air**	**Water**	**Noise**
• Waste Management • Wastewater Treatment	• Urban Particulates and Air Quality • Indoor Air Pollution • Local Ozone • Regional Ozone • NOx and SOx	• Drinking Water • Water Quality Index Water Stress • Water Management	• Noise Pollution
Social, Economics and Health			
• Social Services • Citizen Satisfaction • Education • Culture and Recreation • Social Inclusion • Demographics (Aging)	• GDP • Employment • Financial Resilience	• Adequate Sanitation • Disease Control and Mitigation • Citizen Health Services	

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)"

Scope of "City Level Services" Dimension

Technology and Infrastructure	Sustainability
• Transportation • Buildings • Fire & Emergency Response • Healthcare • Urban Planning • Safety & Security • Education	• Environmental & Natural Hazards • Water – Consumption, Leakage • CO_2 – Emissions, Reduction • Air Quality – NO_x, SO_x ,Particulates • Waste – Solid, Water, Land Use • Policies – Recycling, Reduction • Energy – Consumption, Intensity
Governance	**Economy**
• Organization • Law & Justice • Resilience • Leadership • Commitment • Environmental Regulation	• Economic Strength • Human capital • Institutional Effectiveness • Financial Maturity • Physical (Financial) Capital • Production / Resourcing

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)"
Note that these are not the attributes cited on the next slide!

Scope of "Quality of Life Dimension"

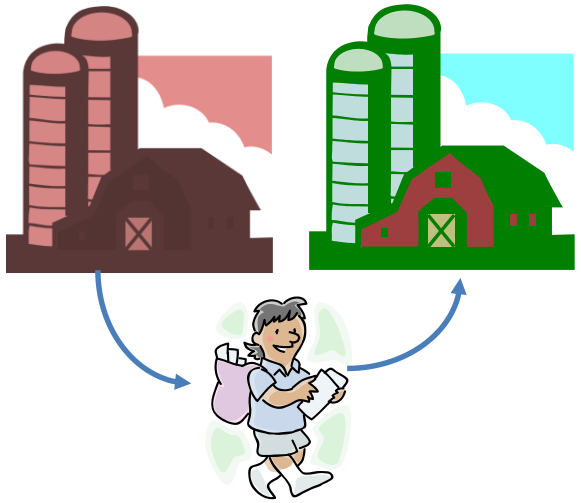
- Reflects on how citizens or inhabitants of a city perceive their own sense of well-being
  - Is migration to urban areas in search of better employment and living conditions justified?
- The multidimensional nature of the Quality of Life incorporates basic needs
  - water, food, shelter, health, jobs (economy), safety and security, education, culture, environment, social equity, technology and innovation

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)", Page 7

Next:
Data Management for the Smart City

Holistic Approach to Data Management

- ✘ In traditional approaches to urban development all the infrastructure systems are managed in silos, with limited communication and information sharing among and across government departments and civil society.
- ✓ Integration can be achieved with ICT tools acting as the "glue" between the different physical infrastructures.
  - For example, ICT could disseminate information on the locations of electric vehicle charging stations in order to optimize traffic flows and energy usage of electric vehicles.



Data Prediction

- *Predictive analytics* describes any approach to data mining with four primary attributes
  - An emphasis on prediction (rather than description, classification or clustering)
  - Rapid analysis measured in hours or days (rather than the stereotypical months of traditional data mining)
  - An emphasis on the business relevance of the resulting insights (no ivory tower analyses) and
  - An emphasis on ease of use, thus making the tools accessible to

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 11

Data Accessibility and Management

- Open and accessible data
  - "Privacy" and the source of most 'sensitive' data can be made anonymous
    - The question of balancing the need for both privacy and accessibility needs to be addressed within a legal and regulatory framework
  - Open Data from energy, utilities, transportation, etc. are to be made public
    - Information sharing allows better operational decisions to be made
    - All data should be presented in a consistent and standardized manner to facilitate Application Programming Interfaces (APIs).
  - Managing Massive Data
    - Information comes in huge packets and needs to be managed using highly efficient databases
  - High Performance
    - Large amounts of data can place a lot of pressure on the workload and operational capacity of existing devices
    - Reliability, accuracy and minimum downtime need to be assured
  - Maximum Efficiency
    - Swift dissemination is crucial for both maximizing and maintaining the role of ICTs

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 12

Next:
Smart Services

Smart Energy

- Smart Energy Management Systems use
  - sensors
  - advanced meters
  - digital controls
  - analytic tools

- to automate, monitor, and control the two-way flow of energy

Source: FG-SSC "An Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 13 and

http://www.slideshare.net/IMDEAENERGIA/smart-energy-management-algorithms

Smart Buildings

- Smart building management systems with up-to-date information can make intelligent modifications to
  - improve building energy efficiency
  - reduce wastage
  - make optimum usage of water
- Occupant satisfaction is increased
  - for both new-build and existing buildings through simple retrofit programs

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 14
and
http://saveonenergy.ca/Business/Program-Overviews/Retrofit-for-Commercial.aspx

Smart Transport

- Smart transportation management systems
  - collect information about mobility patterns
    - enabling city managers to check that existing infrastructure is being used optimally
    - improves the level of citizens' lifestyle in the transportation of goods, services and people

- In addition, ICT can help to reduce the overall need for transportation and travel by offering virtual alternatives to physical movements

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 14

Smart Water #1

- Studies suggest that approximately
  783 million people lack access to clean water
  2.5 billion lack access to adequate sanitation
- The management of water systems is a growing science
  - utilizing, adopting and integrating advanced information technology (IT) remains in the developmental stage
  - hence the Focus Group on Smart Water Management was set up by ITUT/SG5 and had its first meting in Dec 2013

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 14 and http://www.unwater.org/water-cooperation-2013/water-cooperation/facts-and-figures/en/

Smart Water #2

- Some key technologies under study in FG-SWM are
  - Smart Pipes and Sensor Networks
  - Smart Metering
  - Communication Modems
  - Geographic Information Systems (GIS)
  - Cloud Computing
  - Supervisory Control and Data Management (SCADA)
  - Models, Optimization, and Decision-Support Tools
  - Web-based Communication and Information System Tools

Leak Dial

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 15

Smart Waste

- The challenge:
  - With the ever growing increase in consumer goods, wastage has increased exponentially
- The responses:
  - Source reduction, proper identification of waste categories and development of appropriate ways to re-use for the waste
  - Smart Waste Management
    - Implementing waste tracking systems to monitor and control the movement of different kinds of waste
    - Sorting of waste without the operator coming into contact with it
    - Leveraging technology to collect and share data from source to transportation to disposal of waste.
    - Connecting various smart waste management systems with local waste management service providers

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 15 and http://www.thecitiesoftomorrow.com/solutions/waste/challenges/circular-economies-sustainable-cities

Smart Physical Safety and Security

- The challenge
  - Cities will continue to grow, resulting in more and more anonymous threats
- The responses
  - Existing security technology such as video surveillance, video analytics, and biometrics will remain the main focus of a city's security
  - How to manage information flow and analyse the data are the main areas for improvement in the next generation of security*

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 15 and * "Signalling and protocols for visual surveillance" http://www.itu.int/rec/T-REC-H.627-201206-I

Smart Healthcare

- The Objective
  - To improve the productivity of the service provided at the point of contact of patients
- The method
  - Convert health related data into clinical and business insights
    - 'Progressive' organizations and cities are working **together** on their healthcare data to enable secure communications and information sharing
- Related Activity in this area
  - ITU Focus Group to study Machine-to-Machine (FG-M2M) communications was established under the management of ITU-T Study Group 11 in February 2012
    - A "gap analysis" for vertical market M2M service layer needs, initially focusing on applications and services for the **health-care market**.
    - Identification of a minimum common set of M2M service layer requirements and capabilities, initially focusing on **e-health applications and services**.

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" pages 15 and 16

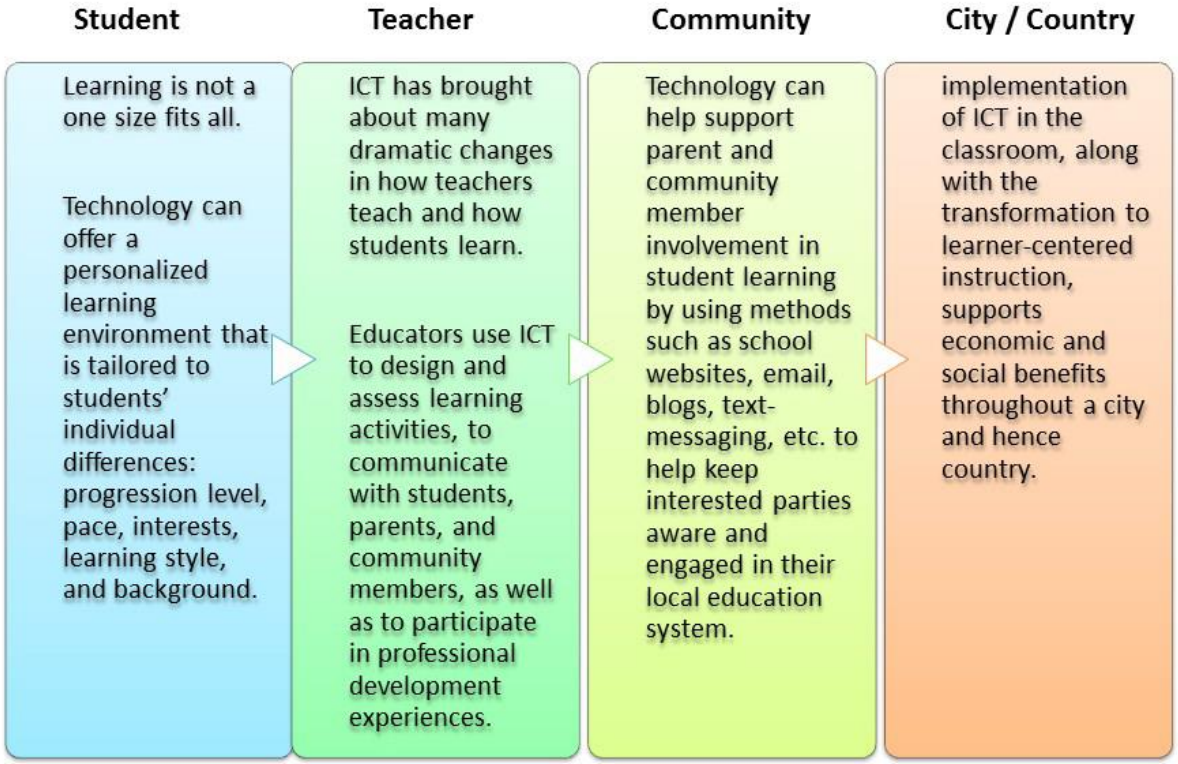
Smart Education #1

- Motivation
  - In the long run, education may be the most important smart city service of all, for adults as well as for children.
- The method
  - The role of Schools and Universities is therefore a key element to consider in the design of smart education solutions

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" pages 17

Smart Education #2

This Figure, adapted from Intel*, summarizes some of the key contributions of ICT tools to education

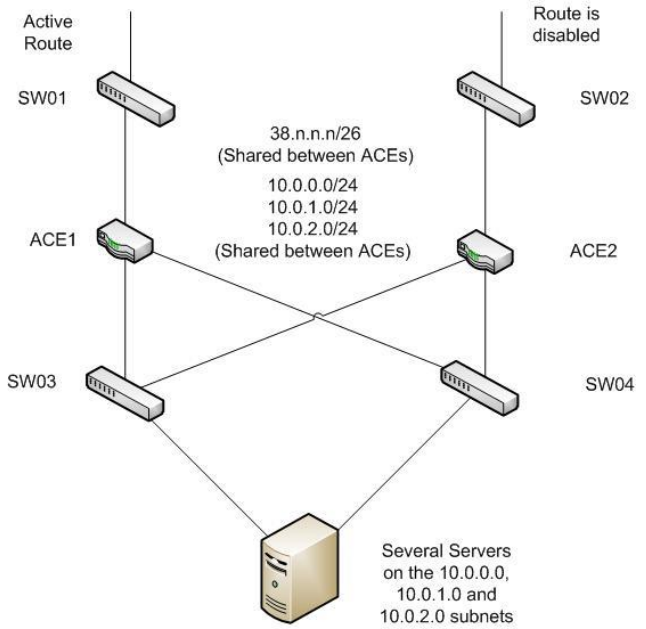


Potential Impact of ICT on Education

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" pages 17 and *http://www.intel.ie/content/dam/www/public/us/en/documents/flyers/education-ict-benefits-infographic.pdf

Next:
ICT Infrastructure

ICT Infrastructure



- In the context of Smart Cities, ICT Infrastructure is a very wide topic and includes most aspects of ICT, both hardware and software
- Smart City ICT infrastructure includes
  - Network Infrastructure, Software Applications, Cloud Computing / Data Platforms and Access Devices
- Communications related applications
  - Building Management, Smart Grids, Physical Safety and Security, Emergency Response, Traffic and Transportation

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" pages 19 and 20

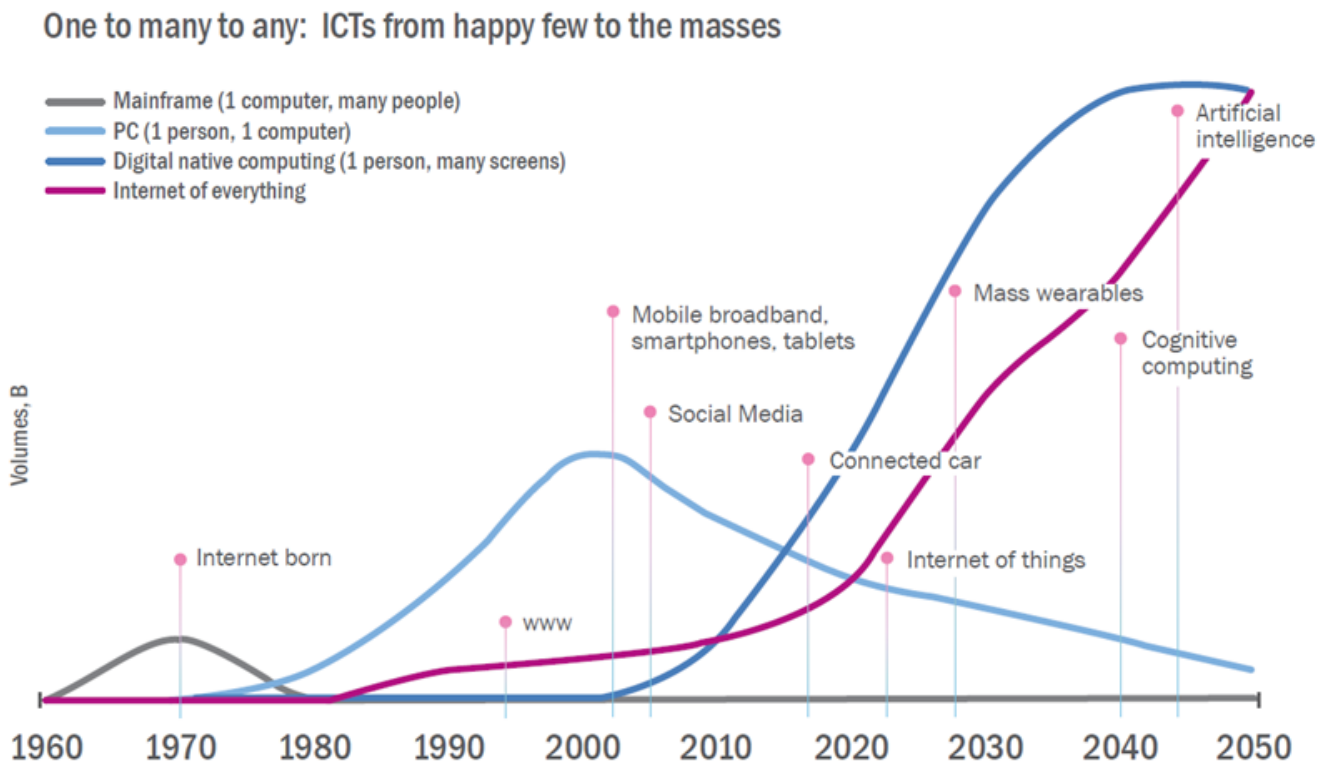
"Internet of Things (IoT)"

- IoT can be viewed as a global infrastructure for the information society, the technology that connects not just humans with things but also things with every other thing
  - By 2020, 30 billion ***things*** will be inter-connected, with each item having a unique IP address
  - Sensors or RFID (Radio Frequency Identification Device) tags will connect ***things*** through the internet to a server (rather like your email operates today but without the human interfaces)
  - Recommendation ITU-T Y.206058* provides an overview of the concept
    - Examples of physical layer interfaces are ZigBee wireless and Bluetooth
    - A gateway function is needed to interconnect devices on different types of physical layer
- Ubiquitous sensor networks (USNs) can be considered as part of the IoT
  - collectively monitoring physical/environmental conditions

  (e.g. temperature, sound, vibration, pressure, motion or pollutants)

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 21
*http://www.itu.int/rec/T-REC-Y.2060-201206-I

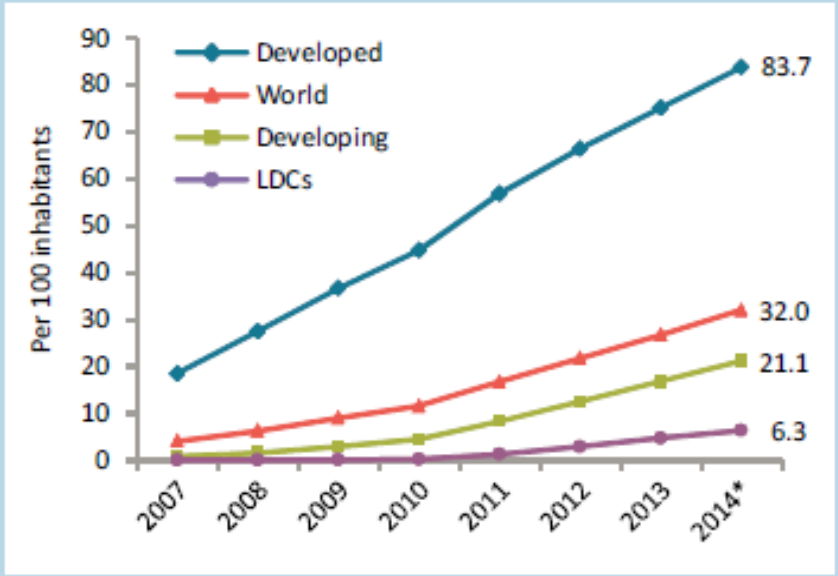
History of the future

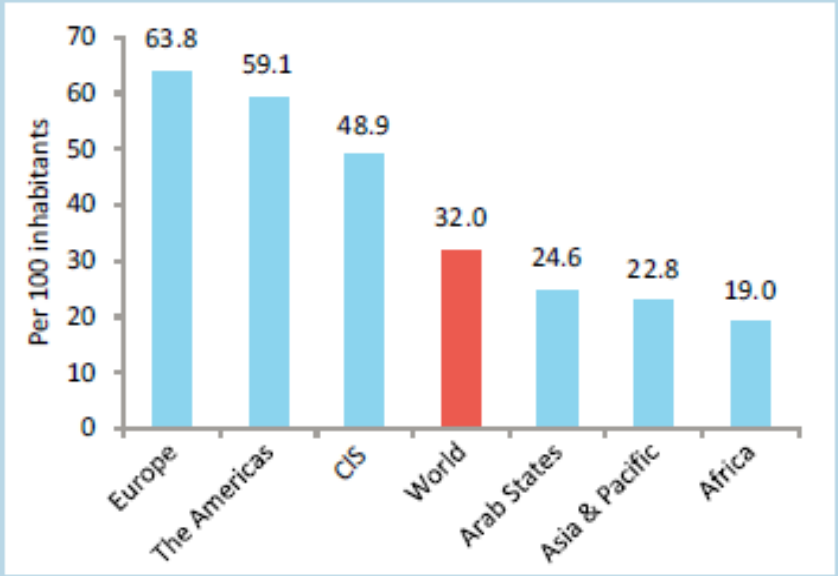


Source: ITU

Mobile Broadband

Chart 1.4: Active mobile-broadband subscriptions by level of development, 2007-2014 (left) and by region, 2014* (right)





Note: *Estimate.
Source: ITU World Telecommunication/ICT Indicators database.

Data Security

- Cities access a lot of information through the ICT system
  - Hence more knowledge but more vulnerability to data security issues
  - The more complex a system is, the higher is the need for cities to protect the data
  - Important services requiring a high degree of security include energy, transportation and healthcare
    - Hackers can wreak havoc on these systems and people using them become vulnerable

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" pages 22 and 23

Emergency/Disaster Response Mechanisms

- A smart city should carry out **risk assessment** with respect to its susceptibility to natural disasters and should have strategies in place to deal with situations to which it is highly susceptible
  - Included are both human induced disasters as well as resilience to natural disasters such as flooding, extreme weather, as well as heat and water stress all linked to climate change
- A smart city's disaster **resilience** solutions should cover
  - observation systems, information gathering capabilities, data analysis and decision making aids
  - these components need to be matched with an intelligent and interoperable warning system to enable cities to respond effectively
- Emergency/Disaster Response Mechanisms
  - Depend heavily on the municipality's uses of ICT infrastructure, including mobile networks, to efficiently receive, process, analyze and re-distribute data, and mobilize various city services
  - (Note. It is most important that these infrastructures are resilient if they are to be useful in event of a disaster!)

Source: FG-SSC "Overview of Smart Sustainable Cities and the Role of Information and Communication Technologies (ICTs)" page 23

Conclusion

- The end goal for a SSC is to achieve a sustainable urban environment without sacrificing comfort and convenience / quality of life of citizens through the use of information and communication technologies (ICTs)

Next: Exercises

Exercise #1 (45 minutes) "Leadership"

Topic for Discussion Groups (4-6 persons)

- Form into Groups
  - Appoint a leader and reporter (with a flip chart)
  - Discuss for 30 minutes and report back (a 2 minute presentation)
- Agree on an example of a challenge relating to SSCs
  - Discuss how a Focus Group could help solve the problem
  - Discuss who the key stakeholders are
  - Suggest the nature of possible deliverables
  - Suggest a possible parent organisation
  - Provide outline recommendations (an action plan)

Exercise #2 (30 minutes) Smart Education

Topic for Discussion Groups (4-6 persons)

- Appoint a discussion leader and reporter
- Question
  - How important is Education in the context of SSCs?
  - What are the advantages of Smart versus traditional education?
  - What are the disadvantages
- Please rank them in order of importance
  - Report back in 20 minutes. A 2 minute presentation is required